EE448/528 - Analytical and Computational Methods in Electrical Engineering I
Fall 1998

Instructor:
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Office Hours: Tue., Thurs. 5:30-6PM (after class), Fri. 3-5PM, or by appointment

Class Material:
1. Class notes available on the EE448/528 web page

http://eb-p5.eb.uah.edu/ece/courses/ee448/

Prerequisites:
Signals and Systems (EE382 or equivalent), Introduction to Linear Algebra (MA244 or equivalent), a working knowledge of MatLab (or equivalent)

Grading:
Homework 10%
Short Quizzes (3) 10%
Two Major Exams 50%
Final 30%

Course Goal:
The course will provide extensive coverage of numerical linear algebra, focusing on algorithms and capabilities that are incorporated into MatLab. Applications of the material will be given in the areas of image compression, the least squares fit of a line to a data set, and n-port electrical networks. While not a course on the program, MatLab will be used extensively.

Partial List of Topics:
I. Numerical Considerations
• Floating Point Representations: Single and Double Precision Formats
• Floating Point Representations: Normalized and Denormalized Numbers
• MatLab’s Response to Overflow and Underflow Numerical Exceptions
• Machine Epsilon
• Rounding
• Catastrophic Cancellation
• Stability of Numerical Algorithms

II. Numerical Linear Algebra
• Vector Spaces
• Linear Dependence/Independence
• Dimensionality
• Basis
• Subspaces, Their Sum and Intersection
• Linear Varieties (Linear Manifold, Flats)
• Inner Products
• Vector Norms and MatLab’s Vector Norm Functions
• Holder and Cauchy-Schwarz Inequalities
• Orthogonal Complement of a Subspace
• Linear Transformations, Range and Kernel, Rank and Nullity
• One-to-One and Onto Properties: The Existence of an Inverse
• Existence and Uniqueness of Linear Transformations Between Subspaces
• Matrix Representation of Linear Operators
• Symmetric/Hermitian Matrices and Their Properties
• Change of Basis: What Happens to the Matrix Representation of a Linear Operator
• Similarity Transformations
• Matrix Norms and MatLab’s Matrix Norm Functions
• Row Echelon Form (Hermite Normal Form)
• Elementary Operations and Elementary Matrices
• Linear Algebraic Equations: Consistent and Inconsistent
• Necessary and Sufficient Conditions for the Existence of Solution(s) to $A\tilde{x} = \tilde{b}$
• Method of Representing Solution Set of $A\tilde{x} = \tilde{b}$
• Linear Functionals and Their Representation
• The Adjoint Operator $A^*$
• The Four Subspaces Associated With $A$ and $A^*$: Range[$A^*$]$^\perp$ = Ker[$A$], Range[$A$]$^\perp$ = Ker[$A^*$]
• Fredholm Alternative as Applied to the $A\tilde{x} = \tilde{b}$ Problem
• Minimum Norm Solution to $A\tilde{x} = \tilde{b}$ for $\tilde{b} \in$ Range[$A$]
• Orthogonal Projection of One Vector onto Another
• Gram-Schmidt Procedure
• The Singular Value Decomposition of an $m \times n$ Matrix and MatLab’s SVD Function
• Singular Values, Right and Left Singular Vectors
• Orthogonal Projection of a Vector on a Subspace: Projection Operators
• SVD Related Projections
• SVD Expansion of an $m \times n$ Matrix
• Application of SVD: Numerical Rank ($\varepsilon$ - Rank) of a Matrix
• Application of SVD: Condition/Sensitivity of Linear Systems and Error Bounds
• Application of SVD: Image Compression
• MatLab’s COND Function
• Minimum Norm Solution to the Least Squares Approximation for $A\tilde{x} = \tilde{b}$ for $\tilde{b} \notin$ Range[$A$]
• Moore-Penrose Inverse (Pseudo Inverse)
• MatLab’s PINV() and \ (back slash) Functions
• Application of Pseudo Inverse: z Parameters of N-Port Electrical Networks in Parallel
• Application of Pseudo Inverse: Least Squares Fit of a Straight Line to a Set of Data
• Eigenvalues and Eigenvectors of a Linear Operator
• Geometric and Algebraic Multiplicities of Eigenvectors
• Necessary and Sufficient Conditions for the Diagonalization of a Matrix
• Jordan Canonical Form of a Matrix
• Function of a Matrix

Reference List:

Hardware/Software/Floating Point Representation

Numerical Linear Algebra, Matrix Theory and Applications


Classical Linear Algebra and Matrix Theory


General Engineering/Applied Mathematics
